Forest Renewal BC Research Program

Final Report

Project Details

FRBC Ref#	CC96020-RE	**SCBC Ref#**	FR-96/97- 030
Project Leader	Mr. Patrick Teti BC Ministry of Forests		
Project Title	Effects of Logging Roads and Road Deactivation on Surface Erosion and Hydrology		
Project Start Date	April 1, 1996	**Project End Date**	September 30, 1997
General Topic	Forest Ecosystems & Landscape Ecology		
Key Words	Forest Ecosystems & Landscape Ecology, Logging Roads, Road Deactivation, Surface Erosion, Hydrology.		

SCBC does not have additional copies of deliverables or products from this project.
Please contact the project leader directly to obtain copies of any deliverables referenced within this report.

FOREST RENEWAL BC

Science Council of British Columbia

Project Administered by the Science Council of British Columbia
For more information, tel: 604.438.2752 fax: 604.438.6564

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FINAL REPORT

October 31, 1997

UNPUBLISHED REPORT

SCBC Number: FR-96/97-030
FRBC Number: CC96020-RE
Awardee's Name: Patrick Teti **Organization**: Ministry of Forests

Title of Project: Effects of Logging Roads and Road Deactivation on Surface Erosion and Hydrology

Report of the full project period - July 1st, 1996 to October 31st, 1997

Overall Objectives

This project was originally proposed to FRBC in January 1996 as a 5 year study to characterize the effects of different types of forest roads on surface erosion and hydrology. The proposal was not accepted as originally submitted but funding was awarded for one year in order to conduct a Problem Analysis which had been proposed as Phase 1 of the original project.

It was recognized from the beginning that the logistical problems associated with measuring the effects of different types of roads on surface erosion and hydrology would be significant. Therefore, the purpose of the Problem Analysis has been to clarify the research issues and the possible methods for addressing them in order to help guide a future research project.

Planned Objectives for This Project

The planned objective for this project was completion of a "problem analysis", which is not self-explanatory. Our interpretation was that the problem analysis would consist of several different components including a literature review, results of a brainstorming session, the results of testing field procedures, and separate reports by consultants.

Final Report on Technical and Extension Activities

Background

Work Done Prior to Current Project

In 1993, a project was initiated to address the issue of surface erosion in the Cariboo Forest Region with funding provided by Ministry of Forests. The purpose of that project was to develop an objective sampling design and survey procedure with which a technician could document surface runoff patterns and erosion features on forest roads. One of the purposes of that project was to determine the effectiveness of waterbar spacing guidelines in the Cariboo Forest Region. A short report on this work was written in 1994 and was distributed to the other hydrologists and geomorphologists in the B.C. Forest Service (Teti 1994). That field project was put on hold due to the active development of new road related guidelines starting at about that time for the Forest Practices Code.

Literature searches related to erosion from logging roads were initiated by the project leader with funding from Ministry of Forests in 1995. This work was continued with funding from FRBC as described under *Literature Review* below.

FRBC Funded Activities

One year of funding was awarded to carry out the first phase of a proposed five year project. The major component of this first phase had already been identified as a "problem analysis" so it was decided that a Problem Analysis would be the main product of this project. The intent is that parts of it would be useful extension product for other researchers, especially the literature review, and that it would also form the basis for an improved research proposal.

At the present time, work done in support of the problem analysis includes a 1994 progress report, an annotated bibliography, notes from a brainstorming session, results of testing field monitoring methods, and two reports by contractors. The sections below describe these activities and products in more detail.

Literature Review

A literature review is a synopsis of the status of knowledge on a particular subject based on the scientific literature. It is done by first searching the scientific literature on a topic, then describing the observations and conclusions of others in an organized way. Literature searches were done by collecting citations, abstracts, and the full text of relevant articles using computer databases and

physical searches in private collections and specialized public libraries. Annotations were derived from a combination of published abstracts and manually written notes.

Searches and annotations were produced by Summit Environmental Consultants Ltd. in 1995 and by the project leader as part of the current work. The combined annotated bibliography is reported in Teti, Guy, and Hamilton (1997) and will form the basis for a literature review as described in the previous paragraph. A literature review is in progress by the project leader with the support of the Ministry of Forests.

Peer Review of the Original Work Plan

Research proposals always benefit from critical review by one's peers. Therefore, one of the activities undertaken for this project was a request for written comments on the original five year proposal, as submitted in January 1995, by colleagues as described below.

Critical comments were requested from 31 individuals with research experience in the Ministry of Forests, Canadian Forest Service, U.S. Forest Service, and consulting companies. Researchers with private companies were offered fixed price contracts to do the critical reviews. Written comments were received from the following:

Will Carr, Ph.D.	Carr Environmental Consultants,
Brian Guy, Ph.D.	Summit Environmental Consultants Ltd.
Sandy Hart, M.Sc.	J.S. Hart and Associates Ltd.
Dan McAllister	Earthworks Environmental
Craig Nistor, M.Sc.	Northwest Hydraulic Consultants, Ltd.
Paul Commandeur	Canadian Forest Service

Anonymous electronic versions of the written comments were provided by the contractors in order to allow the project leader to consider them without regard to personal bias. The project leader compiled the anonymous comments into a single document which he redistributed to all of the contributors for their further review in preparation for a brainstorming session.

Brainstorming Session

A brainstorming session was held in Richmond, BC on February 11, 1997 to discuss the research problem in more detail. The invitees to the brainstorming session included those individuals listed above who had provided written comments, as well as Steve Chatwin from the MoF Research Branch, Peter Jordan from the MoF Research Section, Nelson Forest Region, and Ken Rood from Northwest Hydraulic Consultants. However, Steve Chatwin, Peter Jordan, and Paul Commandeur were unable to attend. Participants included Will Carr, Brian Guy, Sandy Hart, Dan McAllister, Craig Nistor, Ken Rood, and the project leader.

The following are some of the main points that came out of the brainstorming session:

- Studying the effects of roads on hydrology should be regarded as a significant project in itself. Considering the intended duration and budget (5 years and $200,000) in the original work plan, it would be appropriate to drop "and hydrology" from the original title and call it "the effects of logging roads and road deactivation on surface erosion".

- The scale of observation should be a "homogeneous" road segment where the conceptual model is a sediment budget,

$$\text{Net Erosion} = \text{Output} - \text{Input}$$

- It is desirable to document representative long term erosion. However, due to logistics, a study with the current intended budget should not attempt to obtain classic statistical replication of road segments stratified by physical properties but rather should seek to identify the major controlling factors, to rank them, and to test the validity of an initial subjective assessments of erosion by a professional. The results would help clarify the need for future research.

- Large geographic variations in road erosion should be considered first. Scope out a wide range of road related erosion hazards and select representative and suitable sites for monitoring.

- The estimation of erosion from actively used and maintained roads presents a particular problem. Erosion from these roads is expected to be high but measurement is complicated by grading of the running surface and ditch cleanout which can cause large errors in some erosion estimation methods. Therefore, monitoring and measurement methods on active roads need to address these problems.

- The estimation of erosion on inactive and deactivated roads is expected to be simpler. For example, repeated inspection or surveying to detect changes in microtopography might be suitable.

- Major categories of factors interacting with road erosion were identified as on-site, off-site, and anthropogenic. On-site factors include bedrock and surficial geology, biogeoclimatic zone, and slope angle. Off-site factors include distribution of contributing areas and land use upslope, and fluvial connectedness downstream. Anthropogenic factors include road characteristics such as gradient, width, surfacing material, traffic intensity, and maintenance practices.

- The following assumptions are made about roads:

  1. Logging roads are the major source of increased sediment yield associated with forestry activities.

2. The amount of road-related erosion varies greatly with site factors and road characteristics but these can be quantified or categorized. The results can be used to make generalizations and predictions about the contribution of sediment from a network of road segments that have been inventoried according to those traits.

3. If successful, the above methods would allow road related erosion to be estimated for a watershed as a sum of erosion from all road segments. Assuming that factors such as traffic intensity, running surface armoring, maintenance activities, and road deactivation were accounted for in the study, this would allow long term erosion to be compared for different management scenarios. This would help rationalize the costs and benefits of different types of potential erosion control measures in a watershed context.

Test Field Methods

Two field methods were investigated in 1997 for documenting changes in microtopography over time. One was a time lapse camera method and the other was a laser surveying method. These have applications in documenting both the amount of erosion from roads as well as the processes involved.

Automatic Camera System

Two super 8 mm film cameras were purchased which can be triggered in single frame mode by an external contact closure. Hardware and software were configured to control the camera using a Campbell Scientific (CR-10) data logger based on time of day. A custom waterproof enclosure was also designed and built for the camera. This system was successfully deployed at a field site and a time lapse film was produced compressing two and one-half months of field time into two and one-half minutes of playback time.

One disadvantage of this system was the large size of the data logger enclosure, which was larger than the camera enclosure. This made the system unnecessarily conspicuous and visible to potential thieves and vandals. A different microcontroller was subsequently identified and purchased. This unit is much cheaper than a CR-10 ($400 vs $1600) and is small enough to fit in the same enclosure as the camera. Bench tests have indicated that this unit is equally capable of controlling a camera based on either time or some external event such as rainfall intensity.

It is expected that an automatically triggered camera (time based or event based) will be able to provide very useful information on road related erosion during transient events, especially at remote sites. All of the work on the camera systems was done by the project leader. Continued development of these techniques using equipment purchased with FRBC funding is planned by the project leader with the support of the Ministry of Forests.

Surveying Instrument

A laser surveying instrument was rented for three weeks in 1997 for testing (Laser Ranger Scout from Frederick Goertz Ltd.). This instrument measures the relative location of an object in spherical coordinates without the need for hand held reflector. It makes a measurement in about one second at the press of a trigger and saves the data to a laptop computer, thereby allowing data for construction of a 3 dimensional model of a surface to be collected quickly. Its application in monitoring erosion is to survey the microtopography of a road segment from relocatable reference points at various times. The conversion of the data into 3 dimensional models allows small changes in topography to be calculated. The locations and volumes of erosion and deposition can then be determined. It is anticipated that this method would be most useful for long term studies where a site is re-surveyed at intervals of about one year. For testing purposes in 1997, a large near vertical eroding bank was surveyed, a model was produced, and perspective drawings were made. This work was done by Isaac Ferbey, a summer coop student and the project leader with equipment rental funded by FRBC.

Contracted Field Component

Two contracts were awarded for specialists to add to the problem analysis with their own reports. One contract was to address inactive roads and the other to address active roads. The contractors were instructed to investigate and report on the opportunities and limitations to documenting road erosion in the context of the overall project goals for the two different categories of roads. Two reports were produced - Carmanah Research Ltd. (1997) and Earthworks Environmental (1997).

These two reports provide some useful perspectives and ideas for helping to achieve the objectives. The report by Carmanah describes a possible research model with a significant GIS component while the report by Earthworks contains many practical field observations.

Summary

There is no obvious standard by which to evaluate this problem analysis. However, it is suggested that our work has achieved the intent of a problem analysis by identifying limitations and opportunities for addressing the original research objective. It has produced useful extension products and has made some advances with novel field techniques.

Although there is no single document entitled "Problem Analysis", the attachments listed below collectively represent our investigation into the status of knowledge of, and the needs and opportunities for studying "the effects of logging roads and road deactivation on surface erosion". The most significant extension product produced thus far is probably the annotated bibliography on surface erosion related to logging roads.

As discussed in previous sections, a literature review is being produced based on the annotated bibliography with the support of the Ministry of Forests. The various components of work which have contributed to the problem analysis will also provide the background for a future research proposal.

Attachments

Carmanah Research Ltd. 1997. The Effects of Logging Roads on Surface Erosion (Active Roads), A Problem Analysis. Prepared for Cariboo Forest Region, B.C. Ministry of Forests. 34p.

Earthworks Environmental. 1997. Effects of Logging Roads and Road Deactivation on Surface Erosion and Hydrology - Problem Analysis Report for Operational Roads. Prepared for Cariboo Forest Region, B.C. Ministry of Forests. 15p. + Appendices.

Teti, Patrick. 1994. A Survey of Roads as Sediment Sources in the Cariboo Forest Region, Interim report and Request for Comments. 7p.

Teti, Patrick. 1997. Notes from a Workshop at Richmond Inn in support of the Problem Analysis on the project "Effects of Logging Roads and Road Deactivation on Surface Erosion and Hydrology". February 11, 1997. 7p.

Teti, Patrick, Rita Winkler, Brian Guy, and Hugh Hamilton. 1997. Annotated Bibliography of Surface Erosion from Forest Roads. 42p.